

CLAIMS

- 1 1. Apparatus for the delivery of ions generated at atmospheric pressure to a mass
2 spectrometer, the apparatus comprising
3 (a) means for generating an ionization cloud containing charged particles at
4 atmospheric pressure,
5 (b) an entrance opening in the wall of the vacuum system of the mass
6 spectrometer,
7 (c) an ion migration drift tube between the ionization cloud and the entrance
8 opening,
9 (d) means for producing a potential gradient inside the ion migration drift tube,
10 and
11 (e) means to generate a counterstream of gas inside the ion migration drift tube.
- 1 2. Apparatus according to Claim 1 wherein means for electrospraying generate the
2 ionization cloud by spraying a solution containing analyte molecules.
- 1 3. Apparatus according to Claim 2 wherein a pneumatic gas device supports the
2 spraying.
- 1 4. Apparatus according to Claim 2 wherein an arrangement of electrodes and power
2 supplies produce a strong electric field in front of the spray capillary.
- 1 5. Apparatus according to Claim 1 wherein a pulse laser forms an ionization cloud
2 by laser desorption.
- 1 6. Apparatus according to Claim 1 wherein a gas supply device admixes gaseous
2 substances to the ionization cloud.
- 1 7. Apparatus according to Claim 1 wherein a needle for producing corona discharge
2 is arranged in the vicinity of the ionization cloud.
- 1 8. Apparatus according to Claim 1 wherein a UV lamp for photoionization is
2 arranged in the vicinity of the ionization cloud.

- 1 9. Apparatus according to Claim 1 wherein an electron source is arranged in the
2 vicinity of the ionization cloud.
- 1 10. Apparatus according to Claim 9 wherein the electron source contains a foil
2 emitting beta radiation.
- 1 11. Apparatus according to Claim 1 wherein a gas supply introduces the protective or
2 drying gas into the drift tube near the entrance opening of the mass
3 spectrometer.
- 1 12. Apparatus according to Claim 11 wherein a heating device heats the drying gas
2 before introduction into the drift tube.
- 1 13. Apparatus according to Claim 1 wherein the wall of the ion migration drift tube is
2 provided with a large number of electrodes to produce the potential gradient in
3 the drift tube.
- 1 14. Apparatus according to Claim 1 wherein the ion migration drift tube is made from
2 or coated with a resistance material.
- 1 15. Apparatus according to Claim 1 wherein the ion migration drift tube has a conical
2 or trumpet shape where the wider opening is directed towards the ionization
3 cloud.
- 1 16. Apparatus according to Claim 1 wherein the opening of the ion migration drift
2 tube to the spray chamber is covered by a grid which bulges outwards.
- 1 17. Apparatus according to Claim 1 wherein the entrance opening belongs to a
2 transfer capillary, and wherein the outer shape of the tip of the transfer capillary
3 is curved with a small radius of the inscribed vertex circle.
- 1 18. Apparatus according to Claim 1 wherein the entrance opening has a smoothed,
2 slightly funnel-shaped or trumpet-shaped form.

- 1 19. Apparatus according to Claim 1 wherein a device admixes particles to the hot
2 drying gas, the particles being able to neutralize some of the ions in the spray
3 chamber or later in the drift tube.
- 1 20. Apparatus according to Claim 1 wherein the ion migration drift tube is meander,
2 spiral or helix shaped or is bent in some other shape.
- 1 21. Apparatus according to Claim 1 wherein several ion migration drift tubes are
2 connected to one another, either straight or arranged at an angle to each other.
- 1 22. Apparatus according to Claim 1 wherein the entrance grid of the ion migration
2 drift tube consists of a pattern of wires with switchable voltage supplies
3 connected to the wires to either allow or hinder ions to enter the ion migration
4 drift tube.
- 1 23. Method for feeding ions at atmospheric pressure to a mass spectrometer, the
2 method comprising the following steps:
3 (a) forming an ionization cloud containing charged particles at atmospheric
4 pressure,
5 (b) guiding the charged particles by their ion mobility through an ion migration
6 drift tube with inner potential gradient to the entrance opening of the mass
7 spectrometer; and
8 (c) blowing clean protective gas or drying gas into the ion migration drift tube at
9 the side of the entrance opening.
- 1 24. Method according to Claim 23 wherein the ionization cloud is created by spraying
2 a solution containing dissolved analyte from a spray capillary.
- 1 25. Method according to Claim 24 wherein the spraying is pneumatically supported
2 by a spray gas.
- 1 26. Method according to Claim 24 wherein a strong electric field in front of the spray
2 capillary draws charged droplets into the ionization cloud.
- 1 27. Method according to Claim 23 wherein the ionization cloud is created by
2 bombardment of a sample with light from a pulsed laser.

- 1 28. Method according to Claim 23 wherein other gaseous substances are admixed to
2 the ionization cloud.
- 1 29. Method according to Claim 23 wherein a corona discharge produces primary ions
2 in the vicinity of the ionization cloud which lead to chemical ionization of the
3 analyte molecules via a chain of ion-molecule reactions.
- 1 30. Method according to Claim 23 wherein a UV lamp contributes to ionizing the
2 substances in the ionization cloud.
- 1 31. Method according to Claim 23 wherein an electron source contributes to ionizing
2 the substances in the ionization cloud.
- 1 32. Method according to Claim 31 wherein a foil emitting beta radiation is used as an
2 electron source.
- 1 33. Method according to Claim 23 wherein the protective or drying gas is introduced
2 into the drift tube in the neighborhood of the entrance opening of the mass
3 spectrometer and flows through the drift tube in the direction of the ionization
4 cloud.
- 1 34. Method according to Claim 33 wherein the protective or drying gas is heated
2 before being introduced into the drift tube.
- 1 35. Method according to Claim 23 wherein charged particles are admixed to the hot
2 drying gas, whereby the particles neutralize some of the ions which are formed in
3 the spray chamber or later in the drift tube.
- 1 36. Method according to Claim 35 wherein the area around the entrance opening is
2 radiated with UV radiation releasing photoelectrons from the head of the transfer
3 capillary which lead to neutralization of the ions in the outer region of the ion trail.
- 1 37. Method according to Claim 23 wherein the charged particles are generated or
2 admitted into the drift tube as pulses, wherein the drift tube thus operates as ion

3 mobility spectrometer, and wherein the mass spectrometer measures ion of dif-
4 ferent mobilities separately.